The Office of Environment, Safety and Health and its Office of Nuclear and Facility Safety (NFS) publishes the Operating Experience Weekly Summary to promote safety throughout the Department of Energy (DOE) complex by encouraging feedback of operating experience and encouraging the exchange of information among DOE nuclear facilities.

The Weekly Summary should be processed as an external source of lessons-learned information as described in DOE-STD-7501-96, *Development of DOE Lessons Learned Programs*.

To issue the Weekly Summary in a timely manner, the Office of Operating Experience Analysis and Feedback (OEAF) relies on preliminary information such as daily operations reports, notification reports, and, time permitting, conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the summary, please bring this to the attention of Jim Snell, 301-903-4094, or Internet address jim.snell@hq.doe.gov, so we may issue a correction.

Readers are cautioned that review of the Weekly Summary should not be a substitute for a thorough review of the interim and final occurrence reports.

Operating Experience Weekly Summary 97-24

June 6 through June 12, 1997

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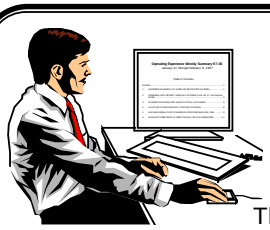

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EVENTS

1. SIX TECHNICIANS CONTAMINATED FROM RADIOACTIVE GAS

On June 3, 1997, at the Brookhaven National Laboratory Medical Research Reactor, radioactive gases released from an irradiated research sample contaminated six technicians. Radiological Control Technicians (RCTs) determined one technician received 200,000 to 1 million dpm beta contamination. The RCTs estimated that this technician received a dose of approximately 90 mrem. The other technicians were contaminated to levels of 5,000 to 20,000 dpm beta and received doses of 15 mrem or less. The primary source of the contamination was chlorine-38 gas. Because chlorine-38 has a half-life of approximately 37 minutes, the RCTs could not determine if the technicians received uptakes. The technicians were unaware that the research sample required special handling and there was a potential for gas release. The failure to properly plan for an infrequent evolution and communicate special handling requirements resulted in contamination of the six workers. (ORPS Report CH-BH-BNL-BMRR-1997-0002)

Researchers use the Medical Research Reactor to irradiate specimens in capsules. In order to minimize the spread of contamination, they frequently wrap the specimens in aluminum foil. At the special request of an off-site researcher, a sample of plastic wrap was inserted into a capsule for irradiation. Engineers evaluated the potential effect of the wrap on the reactor and determined that it would not be affected. However, they failed to evaluate the possible effect of the irradiated plastic on personnel safety. The researcher realized that the capsule would require special handling, but failed to inform the technicians.

After the capsule had been in the reactor for an hour, a technician removed it and placed it in a shielded capsule-handling room. The technician used a remote handling tool to remove the sample from its capsule. He then placed the sample just outside the capsule-handling room to obtain a dose rate reading. The technician determined that the sample read 50 R/hr and returned the sample to the capsule-handling room. While the technician was handling the capsule, it released radioactive gas. The technician was not aware there was a problem because there was no indication that gas had been released. A short time later, two technicians alarmed exit portal monitors as they attempted to leave the facility. Radiological control technicians responded to the scene and discovered the release and contamination of the workers.

Facility personnel are investigating this event to determine its cause and appropriate corrective actions. However, their preliminary analysis indicates that failure to assess potential hazards to personnel from the irradiated plastic wrap and inadequate communications were significant causal factors.

This event is similar to the February 26, 1997, contamination of a researcher at the Lawrence Berkeley National Laboratory. The researcher spilled a small amount of orthosphosphate P-32 while opening a vial. The spill resulted in skin, clothing, and internal contamination of the researcher and contamination to the clothing of two other people. The surrounding area and equipment were also contaminated. Investigators determined there were failings in the system of checks and balances for procuring hazardous materials and chemicals. The researcher was able to procure this radioisotope without the required management reviews and without identifying cautions specific to the material. (ORPS Report SAN--LBL-LSD-1997-0002)

Operating Experience, Analysis and Feedback (OEAF) engineers searched the Occurrence Reporting and Processing System (ORPS) database for personnel contamination events and found 2,675 reports for 2,897 occurrences. Figure 1-1 shows the distribution of direct causes for contamination events DOE-wide from 1990 to present. Equipment failure and personnel error

were the two largest contributors, comprising 63 percent of the events. Communication problems comprised 3 percent of the personnel errors.

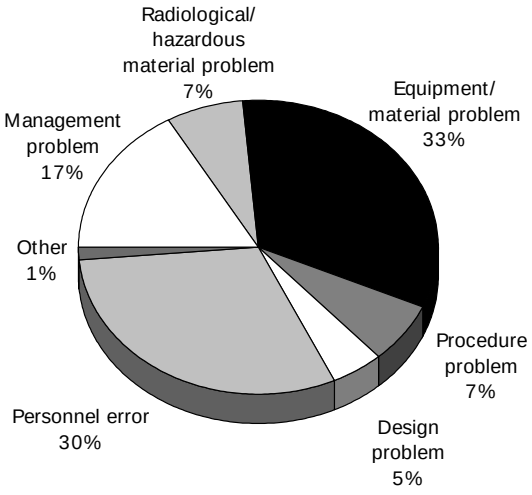

Figure 1-1. Direct Cause of Contamination Events DOE-Wide[1]

The Brookhaven event demonstrates how inadequate communication and inadequate personnel safety analysis of an infrequent evolution can create unexpected radiological hazards. Although the researchers perform many non-routine experiments at the Medical Research Reactor, the handling and processing of the capsules is routine. The non-routine part of this experiment was the use of the plastic wrap. DOE/EH-0256T, *Radiological Control Manual*, section 313, states that at facilities with routine recurring process operations, special management attention should be directed to radiological activities that are infrequently conducted or represent first-time operations. Managers at facilities that perform infrequent or special evolutions should review these activities to ensure that work control processes are followed and all possible contamination mechanisms are evaluated.

National Research Council Publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* 1995, section 2, provides guidance and recommendations regarding prudent planning of experiments. Section 2.c of the publication states that laboratory workers involved with experiments should participate actively and monitor the planning process carefully. The section also states that workers must have the knowledge to ensure their own safety and that of co-workers and society. Information on how order this book can be obtained

[1]OEAF engineers reviewed the ORPS database for the period 1990 to June 9, 1997, AND nature of occurrence code 4B (personnel contamination) and found 2,675 reports and 2,897 occurrences.

from the National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418. This book can also be ordered from most larger book stores.

KEYWORDS: contaminated, reactor, dose

FUNCTIONAL AREAS: Radiation Protection, Research and Development

2. EXOTHERMIC REACTION IN CHEMICAL HOOD

On May 28, 1997, at the Los Alamos National Laboratory, an exothermic reaction occurred in a beaker in a chemical hood at the Radiochemistry Site. The beaker containing a radiological solution. It was warming on a hot plate when the solution flashed, ejecting material onto a plastic-backed paper bench liner, where it began to smolder. Two workers in the room quickly extinguished the smoldering material and made emergency notifications. No personnel contamination or injury occurred. The solution contained nitric acid, hydrogen fluoride, perchloric acid, and an environmental soil sample containing 800 micrograms of plutonium-239. Investigators believe that organic residues, produced when the sample was dissolved in nitric acid, re-entered the solution and caused the reaction. Care should be exercised when working with highly reactive chemicals because of the potential for rapid reactions that can result in a violent release of energy. Such reactions can produce pressures, gases, and fumes that are hazardous. (ORPS Report ALO-LA-LANL-RADIOCHEM-1997-0007)

On May 22, an experienced researcher began processing an environmental soil sample for characterization. To separate the soil sample from its heat-sealed plastic wrapper, he placed it in a 600-milliliter beaker with 25 milliliters of fuming nitric acid. After the foaming reaction stopped and the resulting liquid became clear (indicating no organics remained), he added perchloric acid and hydrogen fluoride until the sample volume was 250 milliliters. He then placed the beaker on a foil-lined hot plate in the hood. The hot plate was on a low setting to allow the acids to "digest" the sample over the next several days. The researcher checked the sample every 1 to 3 hours while it was warming. Each night and over the 3-day holiday weekend, the researcher turned the hot plate off and covered the sample. On May 28, the researcher turned the hot plate on the low setting. Four hours later, workers in the room noticed a flash in the chemical hood and saw gray smoke issuing from the beaker. The bottom 2 inches of the beaker wall glowed and sparks ejected from the beaker onto the bench liner.

Investigators examined the beaker for cracks or flaws and found none. Neither the beaker nor the foil between the beaker and the hot plate showed signs of excessive heat. Investigators checked the operation of the hot plate and found it was operating normally. The researcher believes that the foaming reaction that occurred when the nitric acid removed the organic materials left an organic-containing residue on the wall of the beaker above the level of the liquid sample. During the warming process, the liquid refluxes. Investigators believe that the refluxing acid contacted some residue or some organic material fell into the solution of nitric acid and perchloric acid. The reaction of warm nitric acid and/or perchloric acid and organic material would have been violent.

Facility engineers are reviewing practices and procedures used during this event as well as other laboratory operations to identify any weaknesses that may exist and incorporate changes as necessary.

NFS reported events involving unexpected chemical reactions in Weekly Summaries 96-51, 96-40, 96-38, 96-34, 96-15, 96-10, 95-39, 95-24, 95-23, and 95-04. Weekly Summary 96-40 reported that on September 26, 1996, at the Oak Ridge Environmental Sciences Center, a researcher was adding methanol to two vials containing sodium permanganate and polychlorinated biphenyls when an unexpected energetic reaction caused the mixture to spray

from the vials. Approximately 1 milliliter of the mixture sprayed on the researcher's gloves. Investigators determined that an inadequate evaluation of the chemical compatibility allowed the reaction to occur. (ORPS Report ORO--ORNL-X10ENVIOSC-1996-0001)

These events highlight the need for managers responsible for chemical mixing operations to review their programs for chemical compatibility. Laboratory managers should provide guidance and supervision for chemical mixing at their facility to ensure safety. In facilities where hazardous chemicals are used, workers should be trained in handling chemicals and the potential reactions that can occur. Laboratory personnel need to consider the effects if residual contaminates are inadvertently introduced into chemical reactions. Even when performing routine procedures, personnel should expect the unexpected. If unexpected chemical reactions occur, laboratory managers should suspend these operations and re-evaluate procedures and practices in order to prevent recurrence.

National Research Council Publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* 1995, provides guidance and recommendations regarding the safe handling and storage of chemicals. Section 5.G, "Working with Highly Reactive or Explosive Chemicals," states that perchloric acid and nitric acid are powerful oxidizing agents with organic compounds. Serious exothermic reactions can occur when concentrated solutions are heated with substances that are easily oxidized. The section also provides information on chemical incompatibilities. Information on how order this book can be obtained from the National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418. This book can also be ordered from most larger book stores.

OSHA regulation 29 CFR 1910.1450, *Occupational Exposure To Hazardous Chemicals In Laboratories*, provides direction on the use of chemicals, including signs and labels; spills and accidents; basic rules and procedures; and training and information. OSHA Regulation 29 CFR 1910.1450 is available on the OSHA Home Page at URL http://www.osha-slc.gov/OshStd_data. DOE/EH-0296, Issue 93-2, "Mixing Of Incompatible Chemicals," provides a list of applicable regulations and guidelines as well as recommendations to prevent such events and protect against the consequences if they occur. This publication can be obtained by contacting the Info Center, (301) 903-0449, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72/Suite 100, CXXI/3, Germantown, MD 20874. DOE Defense Programs Safety Information Letter, SIL 96-01, *Incidents from Chemical Reactions due to Lack of or Failure to Follow Proper Handling Procedures,* June 1996, provides guidance to prevent these incidents.

DOE-HDBK-1100-96, *Chemical Process Hazards Analysis,* February 1996, and DOE-HDBK-1101-96, *Process Safety Management for Highly Hazardous Chemicals,* February 1996, provide guidance for DOE contractors managing facilities and processes covered by the OSHA Rule for Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119). Both handbooks are available on the Department of Energy Technical Standards Home Page at URL http://www.doe.gov/html/techstds/standard/standard.html.

KEYWORDS: acid, chemicals, chemical safety, laboratory

FUNCTIONAL AREAS: Chemistry

3. LOCKOUT/TAGOUT VIOLATIONS

This week Operating Experience Analysis and Feedback (OEAF) engineers reviewed four recent lockout/tagout events. On June 6 at Rocky Flats Environmental Technology Site, electricians

violated procedures by removing a lock without authorization. On June 6, Brookhaven National Laboratory reported that an equipment repair contractor violated lockout/tagout procedures by removing a lock on a piece of equipment that was de-energized and locked-out for repair. On May 23 at Rocky Flats Non-Plutonium Operations Facility, a lockout/tagout manager violated procedures by failing to perform a walkdown before issuing a lockout/tagout permit. On May 22 at Rocky Flats Environmental Technology Site, a process specialist discovered that a vent valve, which should have been locked open to prevent the buildup of radiologically generated hydrogen, was locked in the closed position. Lockout/tagouts are installed to provide a barrier for protection of personnel and equipment. Violations of lockouts/tagouts can cause personnel injury or equipment damage. (ORPS Reports RFO--KHLL-771OPS-1997-0027, CH-BH-BNL-BNL-1997-0019, RFO--KHLL-NONPUOPS2-1997-0002 and, RFO--KHLL-NONPUOPS1-1997-0008)

On June 6, 1997, at Rocky Flats Non-Plutonium Operations Facility, the lockout/tagout manager discovered during a records review that electricians had not obtained his approval before removing the lockout/tagout from an electrical disconnect. The facility manager held a fact-finding meeting and determined that the lockout/tagout was never properly installed. Meeting attendees also determined that the electricians violated electrical safety procedures when they performed a voltage check without using personal protective equipment. They determined that the electricians removed the lock from a circuit breaker without the lockout/tagout manager's approval. Meeting attendees also determined that an independent lockout/tagout verification was performed, but it did not prevent this event.

On June 4, 1997, at Brookhaven National Laboratory, laboratory personnel determined that a piece of equipment needed to be locked-out and tagged-out because of a short in the system. On June 6, 1997, an electrician noticed the lock for the equipment lying unattached on top of an electrical panel. The electrician who had originally locked-out the equipment stated that he had not removed the lock. A repair contractor reported that he had repaired the equipment and removed the lock on June 5. However, he was not authorized to remove the lock.

On May 23, 1997, at Rocky Flats Non-Plutonium Operations Facility during a fact-finding meeting, participants determined that a lockout/tagout manager's failure to perform a pre-job walkdown violated procedures. Investigators also determined that electricians removed a lockout/tagout for an air-compressor as directed on the approved lockout/tagout permit. However, the permit was in error, and the lockout/tagout should not have been removed from the air compressor. Removing the lockout/tagout resulted in a potential 120-volt shock hazard to personnel in the immediate area of the compressor. Investigators determined that only one safety barrier (an off-on switch) remained in place to prevent connection of a 480-volt line directly to bare wire.

On May 22, 1997, at Rocky Flats, investigators held a fact-finding meeting and determined a process operator inadvertently locked the valve in the closed position after hydrogen sampling operations. They also determined that an independent verifier failed to identify that the valve was locked in the wrong position. Investigators believe that personnel in the area may have distracted the independent verifier.

OEAF engineers searched the Occurrence Reporting and Processing System (ORPS) database for reports involving lockout/tagout events and found 1,462 occurrences DOE-wide. Figure 3-1 shows the distribution of root causes reported by facility managers for these events. Personnel error represented 36 percent of the root causes; management problems represented 34 percent. Further review of the personnel errors shows that 44 percent were caused by inattention to detail and 43 percent by procedure not used or used incorrectly. A review of the management problems shows that 35 percent were caused by policy not adequately defined, disseminated, or enforced.

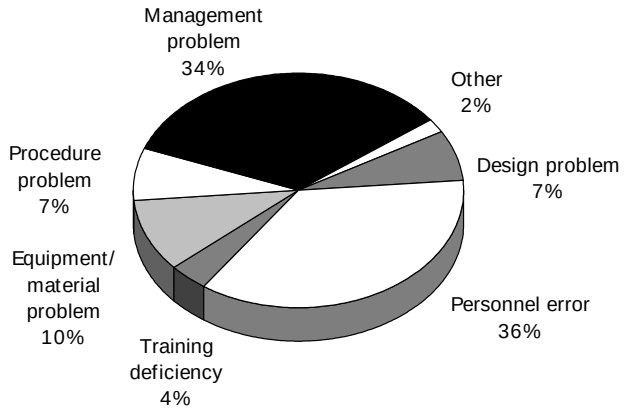

Figure 3-1. Root Causes for Lockout/Tagout Events DOE-Wide[1]

Lockout/tagout programs are essential to ensuring worker safety and to maintaining control over equipment and systems. DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, section 1, "Introduction," states that the primary purpose of lockout/tagout programs is to protect employees from exposure to potential hazardous energy sources. This standard also states that lockout/tagout programs promote safe and efficient operations and are an important element of conduct of operations programs.

DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities,* chapter IX, "Lockouts and Tagouts," provides specific guidance for lockout/tagout implementation, application, and procedures. Chapter X, section C.3, of this standard provides guidance for independent verification and discusses the following items.

- training techniques for verifying positions of facility components
- maintaining integrity of verifications by minimizing interactions
- conducting verifications to actually identify a component and its position

NFS issued DOE/EH-0502, Safety Notice 95-02, "Independent Verification and Self-Checking." The notice presents lessons learned about the necessity of properly performing independent verifications. Independent verification is the practice of having qualified personnel other than the person who performed the task check it for conformance to established criteria. Verification is normally separated from task performance by distance and time to insulate the verifier from the worker's performance. Independent verification is the last barrier available to prevent mispositioned valves. Safety Notice 95-02 can be obtained by contacting the Info Center, (301) 903-0449, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72, Suite 100, Century XXI, First Floor, Germantown, MD 20874.

KEYWORDS: lockout and tagout, independent verification, maintenance

FUNCTIONAL AREAS: Lessons Learned, Licensing/Compliance, Training and Qualification

[1] OEAF engineers searched the ORPS database for the narrative "lockout/tagout" from 1991 to June 1, 1997, and found 1, 414 reports describing 1, 462 occurrences.

4. MISUSE OF ELECTRICAL DRYER SHOCKS AND BURNS TECHNICIAN

On June 4, 1997, at the Weldon Spring Site, a laboratory technician received an electrical shock and burned her right hand when she turned on a hair dryer used to dry soil samples as part of a liquid-limit test for quality control purposes. She dropped the dryer when she felt the shock and saw sparks. Another technician observed the incident and unplugged the dryer. The site nurse treated the technician for first- and second-degree burns on her right palm. No further treatment was required. The hair dryer was a home-use type rated at 1,250 watts (125 volts). Investigators determined that use of the commercial hair dryer had not been authorized by the Safety Department. Inappropriate use of non-industrial grade equipment and tools in the industrial working environment can result in equipment failure and personnel injury. (ORPS Report ORO--MK-WSSRAP-1997-0006)

An electrician inspected the hair dryer and observed a burn hole on the top of the cord on the backside of the dryer and a burn mark on a small area of the case. A short circuit in the electrical cord where it entered the dryer's handle caused the burn damage. The electrician also noticed that the dryer did not have double insulation. The electrician removed the dryer from service.

Weldon Spring quality control laboratory personnel perform numerous tests on soil samples each day. Because the liquid limit test required dry soil samples, laboratory personnel continuously used commercial hair dryers to dry the samples. The dryer that failed was one of three commercial hair dryers in the laboratory and had been used for about 3 months.

Site managers conducted an incident review meeting on June 5 to discuss the event, corrective actions, and lessons learned. They directed that all commercial hair dryers used at the quality control laboratory be taken out of service. They also ordered the procurement of industrial-grade drying tools. The managers issued a lessons-learned document stating that personnel should use only listed industrial grade equipment and tools when performing work on an industrial project. Equipment and tools must be authorized for use and should be inspected daily to identify any unsafe conditions.

This event underscores the importance of using equipment that has been designed and approved specifically for the work application and work environment. Industrial application of commercial equipment, tools, or appliances may result in reduced operating life and eventual failure. The extended operation of commercial hair dryers in the laboratory may have exceeded the manufacturer's intended or recommended use. Laboratory managers and supervisors should ensure that equipment and tools used in the laboratory are (1) approved for use, (2) operated as designed, (3) maintained properly, and (4) inspected periodically.

National Research Council Publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* 1995, provides guidance and recommendations regarding the use of equipment in the laboratory. Chapter 6, "Working with Laboratory Equipment," section 6.C.5.6, "Heat Guns," states that household hair dryers may be substituted for laboratory heat guns only if they have three-conductor line cords or are double insulated. Any hand-held heating device of this type that will be used in a laboratory should have ground-fault circuit interrupter protection to protect against electric shock. Information on how to order this book can be obtained from the National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418. This book can also be ordered from most larger book stores.

KEYWORDS: electrical shock, burn, laboratory, equipment, industrial safety

FUNCTIONAL AREAS: Industrial Safety

OEAF FOLLOWUP ACTIVITY

1. CLARIFICATION OF WEEKLY SUMMARY 97-22, ARTICLE 1, RAPID OVER-PRESSURIZATION OF WASTE SHIPPING CONTAINER

Weekly Summary 97-22, article 1, "Rapid Over-Pressurization of Waste Shipping Container," reported on the over-pressurization and rupture of a shipping container at Fernald caused by a chemical reaction. In the first paragraph of the article, Operating Experience Analysis and Feedback engineers reported that responders to the incident established atmospheric monitoring stations and determined there was no detectable spread of contamination. Subsequent feedback from the field indicates contamination was spread in the warehouse housing the shipping container, but there was no detectable contamination outside of the building.

KEYWORDS: chemicals, chemical reactions, drums, safety

FUNCTIONAL AREAS: Materials Handling/Storage, Industrial Safety